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(54) **Exhaust device for internal combustion engine**

(57) An exhaust device for an internal combustion engine is provided which comprises an inflow port 2, an outflow port 3, and a plurality of thin branched conduits *4a-4d* connecting the inflow port to the outflow port to divide an exhaust gas coming from the inflow port into sub-flows and to join the sub-flows at the outflow port. These branched conduits are spaced from each other to allow an atmospheric air to pass the spaces therebetween and have lengths L_1-L_4 different from each other to provide more reduction by differential phase effect.

FIG. 1

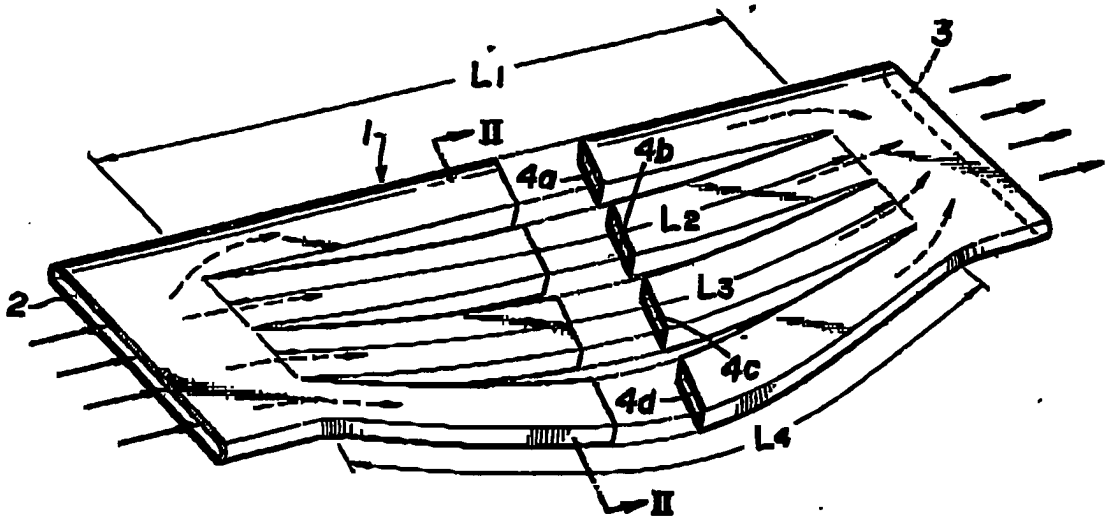

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FIG. 1

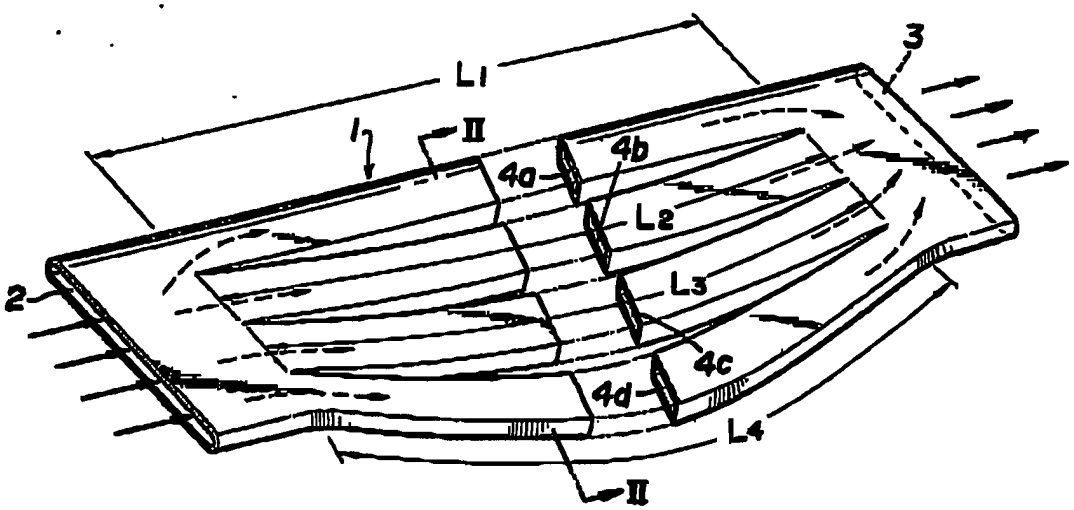


FIG. 2

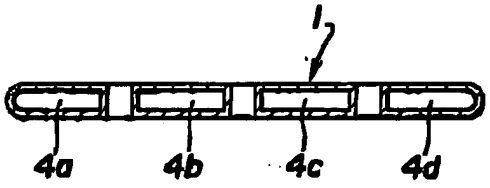


FIG. 3

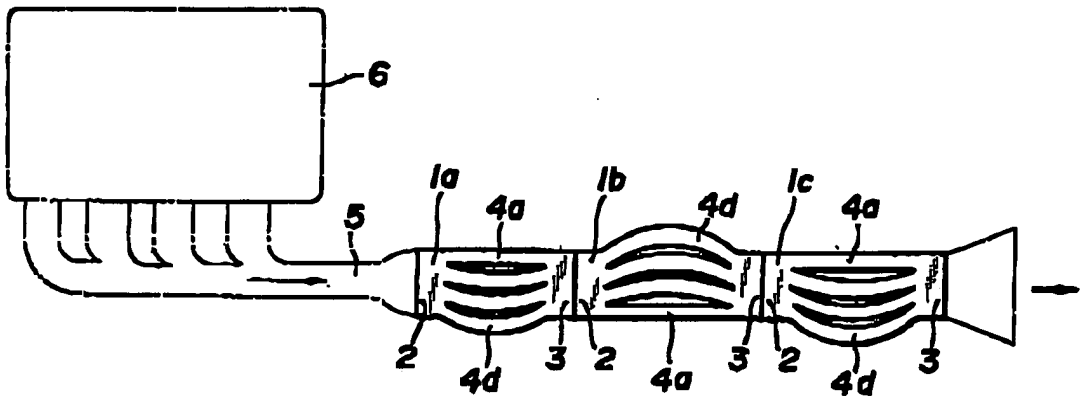
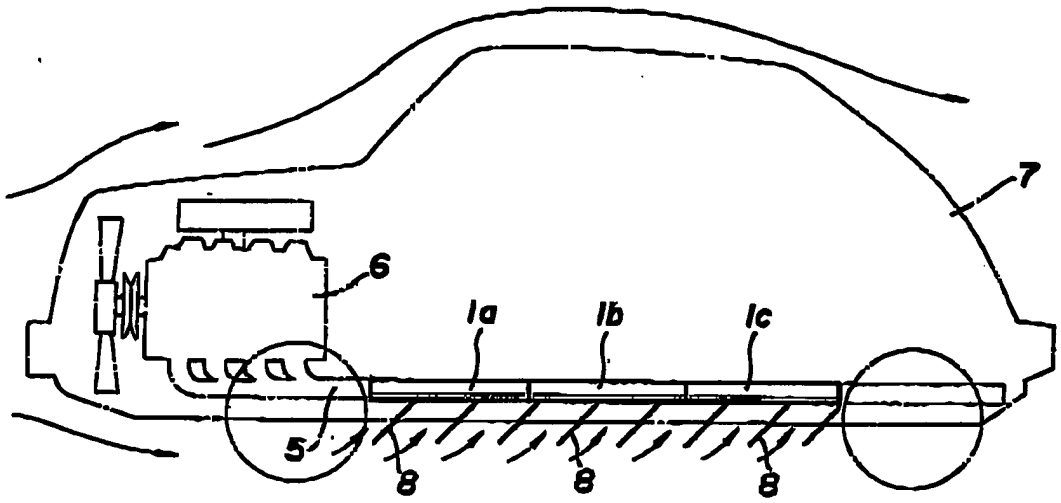


FIG. 4



SPECIFICATION

Exhaust device for internal combustion engine

This invention relates to an exhaust device adapted to be used in connection with an exhaust manifold of an internal combustion engine.

It is desired in an exhaust device of the above type to allow the smooth flow of the exhaust gas not to develop a substantial resistance therein and also to reduce the noise of the exhaust gas discharged to atmosphere.

However, it has been very difficult to fully satisfy the above desired factors simultaneously, because the reduction of noise of the exhaust gas could be obtained by developing a relatively high resistance in the exhaust device. For example, in a known exhaust device, complicated flow passages are formed like a maze so as to smooth the pulsation of the engine exhaust gas and, thereby, to reduce the noise of the exhaust gas discharged into the atmosphere. Such reduction of noise will be obtained substantially in proportion to the complication of the flow passages. However, the complicated flow passages restrict the smooth flow of the exhaust gas with substantial resistance in the exhaust device, so that the back pressure of the engine will be developed to an objectionable degree in the exhaust device, which will cause reduction of the engine output.

Accordingly, an object of the present invention is to provide an exhaust device for internal combustion engine which can satisfactorily reduce the noise of exhaust gas without developing high back pressure therein.

Another object of the present invention is to provide an exhaust device for internal combustion engine which is very simple in structure and low in manufacturing cost.

According to the present invention there is provided an exhaust device adapted to be used in connection with an exhaust manifold of an internal combustion engine, said device being made of a material having high thermal conductivity and comprising an inflow port, an outflow port, and a plurality of thin branched conduits connecting said inflow port to said outflow port to divide an exhaust has coming from said inflow port into sub-flows and to join said sub-flows at said outflow port, said branched conduits being spaced from each other to allow an atmospheric air to pass the spaces therebetween and having lengths different from each other.

Preferably, each of the inflow and outflow ports is a thin transversely elongated opening. Also, each of the branched conduits has a substantially flat rectangular shape in cross section. The branched conduits are curved outside with different radies of curvature.

Other objects and features of the present invention will become apparent from the following detailed description of preferred embodiments thereof when taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a partially sectioned perspective view showing a device according to a first embodiment of the present invention,

Fig. 2 is a sectional view taken along line II-II in Fig. 1,

Fig. 3 is an explanatory view showing a series connection of the present devices in accordance with a second embodiment of the present invention, and

Fig. 4 is a side view of the present devices in Fig. 3 which are incorporated into an exhaust line of an automobile.

Referring to a first embodiment of the present invention shown in Figs. 1 and 2, an exhaust device 1 is made of a material having high thermal conductivity such as aluminum alloy. In this embodiment, the device 1 is formed from thin metal sheets to enhance the heat transmission thereof. The device 1 comprises relatively thin flat and transversely elongated inflow port 2 and outflow port 3, which locate on the same horizontal plane. The inflow port 2 is communicated with the outflow port 3 by way of branched four conduits 4*a* to 4*d*, which are independently separated from each other at the intermediate portion between the inflow and outflow ports but joined together at the vicinity of the inflow and outflow ports 2and 3, respectively. At least, three conduits 4*b* to 4*d* are slightly curved with different radies of curvature so that all of the conduits have different lengths L_1 to L_4 between the inflow and outflow ports 2 and 3, respectively. In this device, each conduit has flat rectangular cross section and is spaced from the adjacent one with an arc-shaped space 5 therebetween.

The exhaust device 1 of the present invention is adapted to be incorporated into an exhaust line of an internal combustion engine of an automobile. For example, the inflow port 3 of the present exhaust device 1 is connected to an exhaust manifold of the engine by means of an adapter (not shown), which has a circular opening connected to the outlet of the exhaust manifold and a flat opening connected to the inflow part 2 of the present device. The present exhaust device has to be connected to the automobile at a place where it is subjected to cooling by flow of air when the automobile is running.

According to such an exhaust device of the present invention, the hot exhaust gas discharged from the exhaust manifold of the engine enters into the inflow port 2 of the present device and is branched into four sub-flows through the four conduits 4*a* to 4*d*. Since the exhaust device is subjected to cooling by flow of air, the exhaust gas flowing through the branched conduits 4*a* to 4*d* is cooled by the air. The cooling effect of the present device is remarkable because of such structures that the branched conduits 4*a* to 4*d* are formed into relatively thin and flat shape from a meterial having high thermal conductivity and separated from the adjacent one to allow the air to freely pass through the spaces therebetween. By such cooling effect, the pressure of the exhaust gas arriving at the outflow port 3 of the present device is remarkably decreased. Thus, the back pressure of the engine at the exhaust line is reduced effectively, with the result that it becomes possible to increase the output of the engine. In addition, since the pressure of the exhaust gas is decreased in

the present device, the degree of thermal expansion of the exhaust gas discharged to atmosphere from the outflow port 3 of the present device is not so great compared with that of the conventional exhaust device, so that the noise caused thereby is diminished in the present device.

Furthermore, the exhaust gas entering into the inflow port 2 of the present device 1 is divided into four sub-flows through the branched conduits 4*a* - 4*d*, which have different lengths, respectively. Accordingly, the sub-flows of the exhaust gas come to have different wave phases from each other while passing through the conduits, which wave phases are interacted with each other at the outflow port 3 of the present device. It will be very easy to preadjust the lengths of the conduits 4*a* to 4*d* in order that amplitude of the mixed wave at the outflow port 3 of the present device becomes much smaller than that of the wave at the inflow port thereof. This will result in the further reduction of the noise of the exhaust gas discharged to the atmosphere.

In the exhaust device according to a first embodiment of the present invention, the branched conduits 4*b* - 4*d* are slightly curved with different radies of curvatures, so that the substantial pressure drop is not developed through the present device. Such structure of the present invention makes it possible to connect a plurality of the present devices in series.

Figs. 2 and 3 show a second embodiment of the present invention in which three exhaust devices 1 of the invention are connected in series with an exhaust manifold 5 in the engine 6. In series connection of the present devices, the intermediate device 1*b* was arranged by turning the device shown in Fig. 1 upside down and connected in such a manner that the inflow port 2 of the intermediate device 1*b* is directly communicated with the outflow port 3 of the adjacent present device 1*a* at the upstream side while the outflow port 3 of the intermediate device 1*b* is directly communicated with the inflow port 2 of the other adjacent present device at the downstream side. Preferably, the present devices 1*a* to 1*c* in series are mounted at the underside of the automobile 7 and a plurality of deflection plates 8 are provided on the devices to deflect the air flow in the horizontal direction against the outer surfaces of the branched conduits of the present devices to enhance the cooling effect while the automobile is running.

As it could be understood from the description of the second embodiment, the series connection of the present devices will have the effect to cool the exhaust gas much more, thereby greatly reducing the noise of the exhaust gas in the atmosphere. Also, the interactions of the sub-flows of the exhaust gas are increased cumulatively while the exhaust gas passes through the branched conduits 4*a* - 4*d*. Accordingly, it becomes possible to remarkably reduce the noise of exhaust gas by preadjusting the lengths of the conduits in order that the amplitude of the mixed waves of the exhaust gas discharged to the atmosphere may become minimum.

Thus, the present exhaust device can be replaced with a relatively expensive conventional muffler, by which the power of the engine is increased, causing the lower fuel consumption of the engine.

Although the present invention has been described with reference to preferred embodiments thereof, many modifications and alterations may be made within the scope of the present invention.

CLAIMS

1. An exhaust device adapted to be used in connection with an exhaust manifold of an internal combustion engine, said device being made of a material having high thermal conductivity and comprising an inflow port, an outflow port, and a plurality of thin branched conduits connecting said inflow port to said outflow port to divide an exhaust gas coming from said inflow port into sub-flows and to join said sub-flows at said outflow port, said branched conduits being spaced from each other to allow an atmospheric air to pass the spaces therebetween and having lengths different from each other.

2. An exhaust device as claimed in claim 1, wherein each of said inflow and outflow ports is a thin transversely elongated opening and each of said branched conduits has a substantially flat rectangular shape in cross section, said branched conduits being curved outside with different radies of curvature.

3. An exhaust device as claimed in claim 1, further comprising a plurality of deflection plates attached thereon to deflect the flow of air against the outer surfaces of said branched conduits while an automobile equipped with said device is running.

4. An exhaust device as claimed in claim 2, wherein said inflow port, said outflow port and said branched conduits are integrally formed substantially on the same plane.

5. A plurality of exhaust devices connected in series to form a long exhaust line and adapted to be mounted at the underside of an automobile, each of said devices comprising a plurality of thin branched conduits there-through to divide an exhaust gas coming from an upstream side into sub-flows and to join said sub-flows at a downstream side, said branched conduits being spaced from each other to allow an atmospheric air to pass the spaces therebetween and having lengths different from each other.

6. Exhaust devices substantially as herein described with reference to Figures 1 and 2 or Figures 3 and 4 of the accompanying drawings.

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